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IDENTIFICATION OF THE CRANIUM OF W.A. MOZART

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Summary

In 1801 at the cemetery in Vienna, Austria, the skull of W.A. Mozart was exhumed (La Chronique Médicale, 13 (1906) 423), and now it has been examined for identification. The osteometrical and osteological findings correspond with the available data of W.A. Mozart. Superimposition gives evidence that craniofacial distinctiveness of the cranium is consistent with the portrait. Additional individual particularities caused by the premature synostosis of the metopic suture (PSMS) and a bone lesion are described.

Key words: Mozart; Identification; German skulls; Craniosynostosis

Introduction

Anthropometric analysis is important for evaluating differences in form between the craniofacial complex of normal individuals and those affected with dysmorphic conditions. The presence of premature synostosis of the metopic suture (PSMS) in the skull of Mozart (1756–1791) [1], deposited at the Mozarteum in Salzburg (Austria), should provide more information to obtain a positive identification [2]. PSMS results in an abnormally shaped skull. The metopic suture that medially separates the frontal bone is usually obliterated in the first two years of life. If fusion starts before birth, the fetal type of angular forehead may persist resulting in a triangular shape known as trigonocephaly [3]. Since the coronal suture is more involved than the metopic suture in the development of the frontal bone, as the frontal eminences develop, the triangular shape is progressively attenuated [4].

It has previously been reported that Mozart had an ultrabrachycephalic skull with a broad midface, alveolar prognathism and a temporo-parietal fracture with an extra-dural hematoma imprint that poisoned part of the last two years of his life and led to a fatal meningitis [2]. The presence of separate conditional traits improve the reliability of the identification.

Materials and methods

PSMS was first described by Welcker [5]. The incidence of uncomplicated

craniosynostosis of the metopic suture in a newborn population was found to be 3/10 000 live births [3], but due to remodelling of the skull we found the incidence in adults to be 1/10 000 [6].

Clinical symptoms are characteristic craniofacial deformities. Radiographic signs are diagnostic in newborns, providing additional characteristic changes not apparent clinically. The metopic suture is in part or totally replaced by abnormally thick bone, the orbits are egg-shaped with longer axes extending from the infero-lateral angle of the orbit to glabella, the coronal sutures are more clearly defined than normal and have anterior curving of the upper limbs approaching the bregma [7,8]. These morphological features may be clearly seen in dry skulls of adults with PSMS. Although self-correcting frontal remodelling mechanisms are important in PSMS, due to the slight contribution of the metopic suture in skeletal growth appeared to the coronal, the signs can persist in the adult skull and therefore be distinguished from measurements on dry skulls drawn from samples genetically similar to the affected individual.

Since Europoids are heterogenous in skull characteristics, the distribution of nasion-bregma and bregma-lambda chords has been plotted separately in Rumanian, Hungarian, Austrian, Swiss, and South German males. These measures were chosen because the frontal bone is short in PSMS [7]. The skulls are from the Musée de l'Homme in Paris, France. Examinations were specially performed on ten hyperbrachycephalic South German skulls since race and general morphology both affect the frontal appearance. The data obtained have been compared to a control series of males from the village of Berg, Austria, whose narrow genetic origin helps us to understand the limits of intrapopulation variation and to evaluate the effects of drawing skulls from diverse backgrounds as they are in a museum. By this means we hope to appreciate relative intra- and interpopulation variation.

Standard measures from Howells [9] have been coupled with cranial traits selected to elucidate the specific clinical problem. Twenty three measurements of the cranium have been recorded for Mozart of which thirteen have been compared with the Berg population, and fourteen measurements are compared with the hyperbrachycephalic South Germans.

Results

The skull of Mozart is incomplete with its base sawn off across the center of the external auditory meatus (Fig. 1). Careful observation on all surfaces reveals cutmarks, and knife notches are present around the edge of the nasal aperture. The distribution of the marks on the cranium suggests the removal of flesh with a steel knife. Detection of mineral and plant particles, however, gives evidence of burial. A fracture of the left temporal and parietal bones with signs of healing and imprint of a calcified epidural hematoma above 45 cm^3 has been noted.

The cranium is 168 mm long and 149 mm wide (cranial B/L index 88.7) and

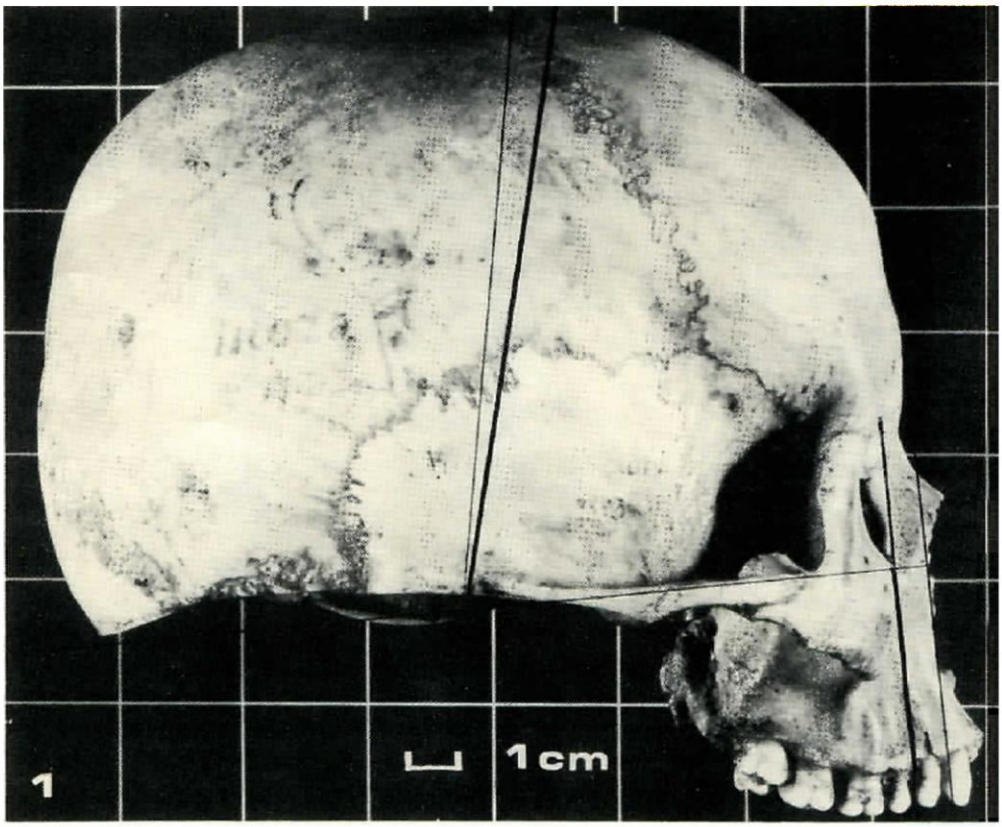

Fig. 1. The skull of W.A. Mozart is short, the forehead is straight, the orbitale and subnasale are advanced, and the anterior end of the palate is in a forward position.

the cranial capacity has been provisionally estimated to be 1585 cm^3 (Table 1). The forehead is vertical as evidenced by the facial angle measured on the Frankfort plane. The anterior end of the palate is in a forward position and the orbitale and subnasale are also advanced. The maximum external breadth of the frontal bone at the coronal suture is broad (131 mm). Transillumination shows several thin areas in the frontal bone suggesting brain contact closer than normal in relation to the temporo-parietal fracture [10].

The straight forehead, with frontal eminences spaced 64 mm apart, is slightly wedge-shaped at the base giving poor eye protection in the superior part of the orbits. The orbits are reduced with an ovoid shape evidenced by the open angulation of the superolateral orbital margins (Fig. 2). In the supraglabellar sulcus a slight midline bone thickening is present with many small vascular channels (Fig. 3). The limbs of the coronal suture have an anterior curvature at bregma that produces an extension of the sagittal

TABLE 1

SKULL MEASUREMENTS IN MOZART COMPARED TO THE BERG MALE MEANS*

Values except Orbital volume and Cranial capacity expressed as mm

	Mozart	Berg male (n = 55)
Glabello-occipital length	168	180.3
Maximal crandial breadth	149	147.6
Minimum frontal breadth	97	99.6
Maximal frontal breadth	131	124.6
Porion-bregma chord	110	–
Head horizontal circumference	504	–
Biporion perimeter	324	–
Nasion-bregma arc	119	–
Bregma-lambda arc	135	–
Nasion-bregma chord	105.7	111
Bregma-lambda chord	113.6	110.1
Bi fronto-malar-temporal	104	–
Biorbital breadth	94	–
Interorbital breadth	24	22.9
Bizygomatic breadth	136	135.5
Zygomaxillare	91	–
Nasion-prosthion height	64	67.9
Orbit breadth	36	40.1
Orbit height	33	33.7
Orbit volume (cm^3)	25	–
Nasal height	49	51.7
Nasal breadth	23	25.5
External palate breadth	65	–
Cranial capacity (cm^3)	1585	–

*From Howells 1973 [9].

suture into the frontal region. The coronal and sagittal sutures are wide with complicated interdigitations that clearly define them.

Additional independent traits relevant to identify the skulls are a pronounced alveolar prognathism evidenced by the direction of the nasoalveolar clivus and a short vertical dimension of the alveolar process. The four incisor crown are missing, but the roots and alveoli are preserved so that it is possible to determine the angle at which they are set. The axes extend forward, 120° from the Frankfort plane, therefore the teeth must have been in 'prodonty'. With a dental arcade index 130, the shallow palate is considered to be broad. Assignment of age on the basis of dental wear allow only a gross approximation, however tooth wear and root closure of the third molar are consistent with our clinical experience of an individual 25 – 40 years old.

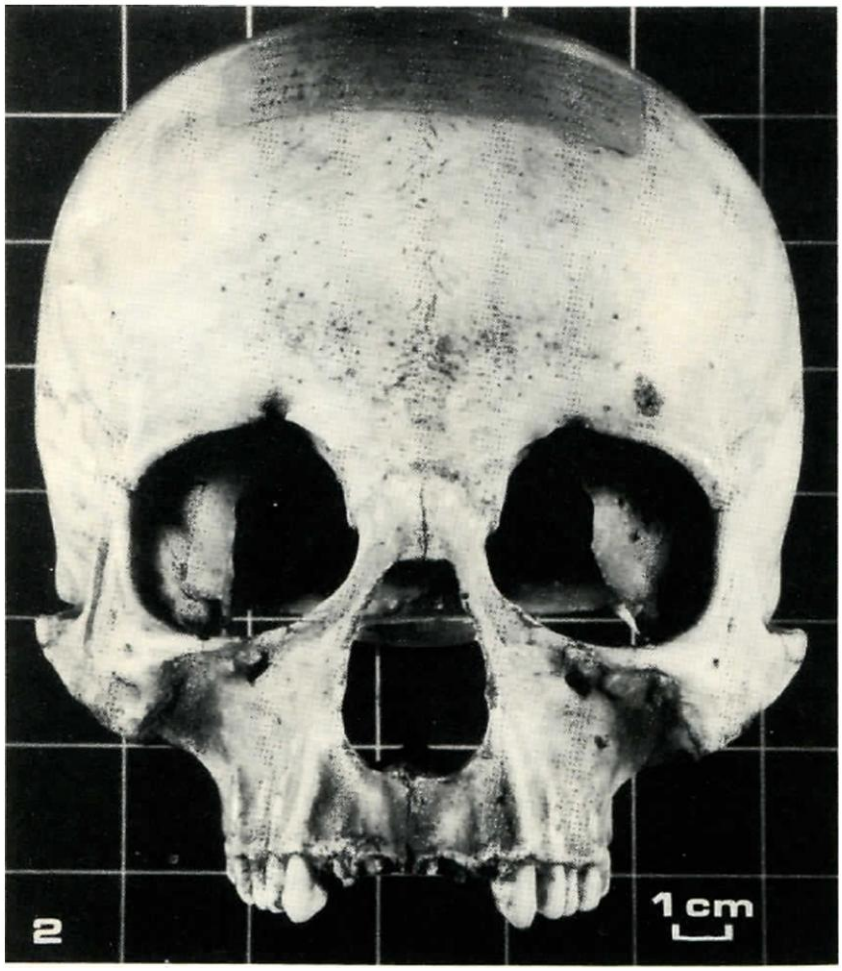

Fig. 2. PSMS in Mozart is evidenced by a medial supraglabellar protuberance associated with small vascular channels, a restricted orbital volume and a broad maximum external breadth of the frontal bone at the coronal suture.

Discussion and conclusion

Comparison of the anthropological measurements with the Berg population shows that the form of the skull of Mozart is, on the whole, typical of the male South German brachycephalic. Skull contour, involving flattening of the posterior part and the large midface are marked features (Table 1). The forward shifting of bregma may be present in Central Europoid males without implying any dysmorphism (Table 2). Orbital dimension is commonly considered as a sexually dimorphic trait, thus the orbital dimension in Mozart (volume of 25 cm^3), gives a feminine appearance to the face. As a con-

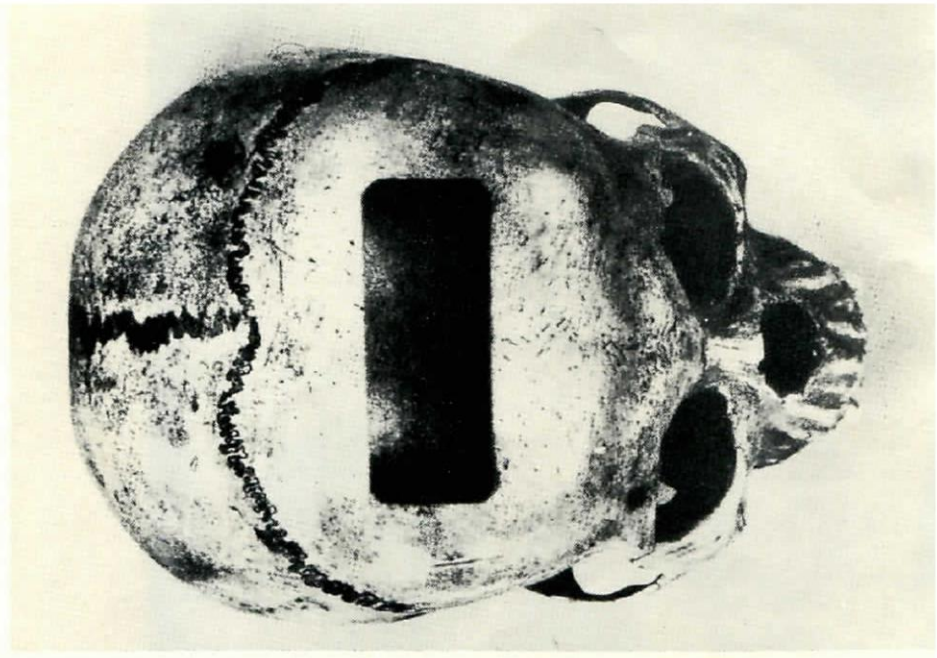

Fig. 3. The coronal suture has upper limbs anteriorly curved at the bregma. The coronal and sagittal sutures are wide with complicated interdigitations. Note the medial protuberance of the frontal bone.

sequence of reduction of the anteroposterior dimension of the frontal bone an increase in the external frontal breadth at the coronal suture (Table 1) gives an egg-shaped configuration to the fact. The index of nasion-bregma chord/maximum frontal breadth is 80.7 in Mozart and 90.4 in the comparative series.

The cranium, metrically similar to that of hyperbrachycephalic South German male crania (Table 3), has in the frontal bone anomalies associated with PSMS. Disturbances in skeletal growth include shortening of the nasion-bregma chord, upper limbs of the coronal suture anteriorly curved, a normal external breadth of the frontal at the coronal suture, reduction of the orbital dimensions, and a supraglabellar midline thickening surrounded by many small furrows caused by blood stasis. These dysmorphic traits occur together in Mozart's cranium. We failed to document metrical cranial differences between individuals with PSMS, due to its low incidence. We found four cases in the Musée de l'Homme in Paris for a total of 30 000 skulls examined, and only one skull is from an adult.

Given the apparent craniofacial distinctiveness of the cranium (e.g. vertical forehead, reduced orbits, and alveolar prognathism) we have superimposed the cranium on the portraits to show that the forehead con-

TABLE 2

LENGTH OF THE FRONTAL AND PARIETAL BONES IN THE SAGITTAL PLANE OF EUROPOID SKULLS

Values expressed as mm.

Group	*N*	Nasion-Bregma		Bregma-Lambda	
		Range	Mean	Range	Mean
German	42	106–120	113	106–117	113
Austrian	30	106–118	111	102–118	110
Rumanian	29	101–117	107	96–118	107
Swiss	37	105–119	112	100–119	109

tour, nasal profile, orbit shape and cheek position correspond. The examinations were made with the portraits drawn on wax in 1778 (collection André Meyer) and in 1788 by L. Posch. Complete conformity has been found to exist concerning all side proportions of the head.

Topographic reference points served as the position of the corners of the eyes at the malar tubercules, glabella, nasion, subortbitale, the insertion of the nose wing on the inferior nasal spine, and porsthion. Features of the topography of the profile are identical in detail (Fig. 4). Nasion is

TABLE 3

CRANIAL MEASUREMENTS IN MOZART COMPARED TO HYPERBRACHYCEPHALIC SOUTH-GERMAN MALE SKULLS

Values expressed as mm.

	Mozart	South-German (n = 10)	
		Mean	Range
Glabello-occipital length	168	179	173–183
Maximum cranial breadth	149	148	141–157
Head horizontal circumference	504	517	500–540
Bizygomatic breadth	136	135.4	130–141
Nasion-bregma chord	105.7	113	106–120
Bregma-lambda chord	113.6	113	106–115
Minimum frontal breadth	97	97.7	92–105
Maximum frontal breadth	131	125	120–130
Orbit height	33	36	31–39
Orbit breadth	36	38.5	36.5–41
Nasal height	49	52	49–58
Interorbital breadth	24	23.4	22–26
External palate breadth	65	64	62–67.5
Palate length	50	51	50–53

approximately two millimeters higher the sellion, suborbitals is established relatively well on the portrait by the more or less sunken soft tissues of the orbit under the eye.

History claims that the remains of Mozart were lost among the mixed bones in St. Marx's cemetery in Vienna. In fact Mozart was buried in 1791 in a four plot site, part of a sixteen plot area. Due to the widespread head-hunting custom of the epoch by anatomists, the skull was rescued by the gravedigger and its history is well known since 1842, also the date of the death of Mozart's widow.

The identification becomes absolute with the multiplication of specific traits. Mozart had a cranio-facial dysmorphism initiated by PSMS. Dysmorphism is involved in some of the unusual aspects of the Mozarteum skull. PSMS is shared in its uncomplicated form in adults, only by 1/10 000 persons. The incidence of PSMS with other independent traits such as marked cheek-bones and prodonty with projecting nose and upper maxilla in a 25–40 years old skull becomes much less than this.

The presence of a healing temporo-parietal fracture on the left side with extra dural hematoma, is likely to have initiated the meningeal coma diagnosed in Mozart by Dr. Thomas Franz Closset. In fact, Closset suspected a cerebral edema with an associated clot [11]. This gives additional positive identification of Mozart by joint probability. Among the three types of coma invoked for Mozart by Hildesheimer [12] – renal, by poison, meningeal – meningeal coma from fracture with the associated modifications is sufficient to explain Mozart's very rapid decline. In adults, extra dural hematomas carry a propensity (82%) for deterioration [13]. The fracture is supposed to have been the result of a fall that was soon forgotten by Mozart.

Acknowledgements

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